PB89-130470

Regulations Concerning the Use of Geosynthetics in Waste Management Facilities

(U.S.) Environmental Protection Agency
Cincinnati, OH

Nov 88

U.S. Department of Commerce
National Technical Information Service
NTIS

PB89-130470

EPA/600/D-88/249
November 1988

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by

Robert E. Landreth
Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

RISK REDUCTION ENGINEERING LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

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U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA (Please read Instructions on the reverse before completing)		
1. REPORT NO. EPA/600/D-88/249	2.	3. RECIPIENT'S ACCESSION NO. PB89 130470/AS
4. TITLE AND SUBTITLE Regulations Concerning the Use of Geosynthetics in Waste Management Facilities		5. REPORT DATE November 1988 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Robert E. Landreth		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS USEPA/RREL/WMDDRD/MSWRMB/LTS 26 West Martin Luther King Drive Cincinnati, OH 45268		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Risk Reduction Engineering Laboratory--Cincinnati, OH Office of Research and Development U.S. Environmental Protection Agency Cincinnati, OH 45268		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE EPA/600/14
15. SUPPLEMENTARY NOTES Robert E. Landreth FTS: 684-7836 COMM: 513/569-7836		

16. ABSTRACT

Regulations for hazardous and nonhazardous waste containment facilities as they impact the potential use of geosynthetics. A summary of the Subtitle "C" and "D" liner regulations are presented.

17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS (This Report) UNCLASSIFIED	21. NO. OF PAGES 13
	20. SECURITY CLASS (This page) UNCLASSIFIED	22. PRICE PC A03/MF A01

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

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Robert E. Landreth
U.S. Environmental Protection Agency
Risk Reduction Engineering Laboratory
Cincinnati, Ohio

The U.S. Congress, through the Resource Conservation and Recovery Act of 1976 (RCRA) and its 1984 Hazardous and Solid Waste Amendments (HSWA), challenged the U.S. Environmental Protection Agency (EPA) to develop standards for the management of both hazardous and nonhazardous wastes in this country in a manner that would protect human health and the environment. The EPA, through its experience in field activities and research, continues to refine the control strategies by incorporating state-of-the-art materials and design alternatives. Although the EPA-developed regulations for waste management facilities may presently appear burdensome, the regulations and guidance will continue to be updated as construction materials are better understood and as design concepts are verified.

The current status of hazardous waste (Subtitle "C") and nonhazardous waste (Subtitle "D" of RCRA as amended by HSWA) regulations are summarized below, this summary also includes proposed regulations. Geosynthetics, including flexible membrane liners (FMLs), geonets, geotextiles, and plastic pipes, play a major role in the control technology for managing waste when their design limitations are not exceeded. Systems, to meet the control strategy e.g., cover systems, liner systems, etc., are discussed rather than individual components.

Subtitle "C"

Under Section 3004 of RCRA, owners and operators of treatment, storage, and disposal facilities (TSDFs) are required to comply with standards "necessary to protect human health and the environment." Since enactment of RCRA, EPA has promulgated interim status and permitting standards governing the design, operation, and maintenance of landfill, surface impoundment, waste pile, facilities used to treat, store, or dispose of hazardous wastes. These standards included Part 265 requirements applicable during the interim status period and Part 264 requirements applicable to permitted units.

On July 26, 1982, EPA promulgated technical and permitting standards under Part 264 for landfills, waste piles, surface impoundments, and land treatment units. These regulations consisted of a set of design and operating standards separately tailored for each type of unit. The design and operating standards required landfills, surface impoundments, and waste piles to have a liner and leachate collection system to prevent migration of wastes to the subsurface soil or to ground water or surface water during the active life of the unit.

On November 8, 1984, amendments to RCRA entitled the Hazardous and Solid Waste Amendments (HSWA) were signed into law. HSWA adds additional technological requirements to the design standards for land disposal units. The new Section 3004(o)(1)(A) of RCRA added by HSWA requires new landfills and surface impoundments, each new landfill and surface impoundment unit at existing facilities, and each replacement or lateral expansion of a landfill or surface impoundment at existing facilities for which a permit application is received after November 8, 1984, to install two or more liners and a leachate collection system above (for landfills) and between the

liners. Under Section 3004(o)(2), the minimum technology requirements set forth in Section 3004(o)(1)(A) will not apply if the owner or operator successfully demonstrates that alternative design and operating practices together with location characteristics will prevent the migration of any hazardous constituents to ground water or surface water at least as effectively as such liners and leachate collection systems. Section (o)(3) sets forth a variance from the minimum technology requirements for certain monofills.

On July 15, 1985, EPA issued a final rule to amend the existing hazardous waste regulations to reflect those statutory provisions of HSWA that took effect immediately after enactment. This rule incorporated into the existing hazardous waste regulations the Section 3004(o)(1)(A) regulations, requiring certain permitted and interim landfills and surface impoundments to have double liners and leachate collection systems. The July 15, 1985, regulations set top liner standards that could be met by a flexible membrane liner (FML), and bottom liner standards that could be met by three feet of compacted soil or other natural materials with permeability of no more than 1×10^{-7} cm/sec. In the Proposed Codification Rule of March 28, 1986, EPA proposed amendments to these double liner and leachate collection system requirements. The March 28, 1986, proposal set forth two designs for double liner systems. One design consists of FML top liner and a composite bottom liner consisting of a FML underlain by a low permeability soil layer, such as clay. The alternative design entails using a FML top liner and a clay bottom liner sufficiently thick to prevent migration through it during operation and post-closure care. When data

from saturated and unsaturated hydraulic flow models were reviewed, however, the composite liner was found to improve liquid management strategy. EPA is now considering eliminating this alternative design.

The proposed double-liner rule (March 28, 1986 (1)) gives general performance criteria for LCRS at hazardous waste landfills and surface impoundments. The LCRS above the top liner at a landfill must cover all areas of the FML liner, with side wall coverage optional, although most landfill designs include a LCRS on the side walls. The LCRS between the two liners (top FML and bottom composite) must cover all areas of the bottom and side walls of the unit. This system is normally referred to as the leak detection, collection, and removal system (LDCRS). Geonets and geotextiles play an important role in these systems by allowing the designer to increase the side slope angles (more free air space) while adhering to the requirements.

Section 3004(o)(4)(A) of RCRA requires EPA to issue standards by May 8, 1987, requiring new landfills, surface impoundments, waste piles, land treatment units, and underground tanks to use approved leak detection systems. The statute defines an approved leak detection system as a system or technology that is capable of detecting leaks of hazardous constituents at the earliest practicable time.

On May 29, 1987, EPA proposed leak detection standards. The Agency proposed specific performance and design standards for an approved leak detection. Essentially, the leachate collection and removal system (LCRS) requirements proposed by the Agency on March 28, 1986, form the basis of the proposed leak detection requirements. However, rule proposes to modify these LCRSs by specifying the following design criteria: a minimum bottom

slope. drainage layer hydraulic conductivity and transmissivity, and a sump of appropriate size to collect and remove liquids efficiently. Additionally, the system must be capable of detecting a specified leak within a certain time period and must be able to collect and remove liquids rapidly to minimize head on the bottom liner. In lieu of meeting these requirements, the owner and operator may receive a variance for an alternative system that meets certain specifications. The detection time was set at 1 day. The leak rate of 1 gallon per acre /day (gpad) was based on expected design performance of a composite bottom liner in a double liner system. The minimum design criteria for the LDCRS are (a) bottom slope of 2 percent; (b) drain layer hydraulic conductivity of 1 cm/sec (c) thickness of 30 cm (for granular materials) and (d) hydraulic transmissivity of 5×10^{-4} m^2/sec (for synthetic materials). The sump is designed to detect leakage and allow daily flow monitoring.

In addition to the design criteria discussed above, the owner and operator must establish an action leakage rate (ALR) during the design of the unit. The ALR is the rate of leakage from the top liner into the LCRS that triggers interaction between the owner or operator and the Agency to determine the appropriate response action for the leakage. The ALR proposed consists of a range between 5 and 20 gallons per acre per day. In the final rule, the Agency intends to select a value within that range as the appropriate ALR.

When the leakage from the top liner exceeds the ALR, the owner or operator is required to implement the appropriate site-specific response activity for leakage. EPA also proposed that the owner or operator develop a response action plan (RAP) which consists of an assessment of the reason for leakage, the current conditions of the unit components (e.g., bottom

liner and leachate collection and removal system), the potential for migration out of the unit of hazardous constituents at levels exceeding health-based standards, and an assessment of the effectiveness of various responses.

Under the proposal, the time when a RAP must be submitted depends upon the rate of the leakage. For rapid and large leakage, the owner must submit a RAP before the unit receives waste. For leakage that exceeds the ALR, but is less than rapid and large, a RAP must be submitted no later than 90 days after the ALR is exceeded. The RAP proposed by the owner or operator must be reviewed and approved by the Regional Administrator (RA). During this time (from determination of exceedance of the implementation of the RAP) the owner or operator continues to operator the unit and collect and remove leachate.

The current schedule for publishing the final regulation is the fall of 1989. Although existing facilities do not have to meet these requirements, existing double-liner facilities may be required to develop ALR and RAP criteria based on site specific capabilities.

Subtitle "D"

The basic requirements for managing nonhazardous solid waste is contained in 40 CFR Part 257, promulgated in 1979. As part of HSWA (1984), Congress directed EPA to reassess and revise, if necessary, these criteria for landfills that receive hazardous household waste and small-quantity-generator hazardous wastes. Based on new study data, the Agency decided to revise Part 257 criteria in phases (4). On August 30, 1988, the Agency proposed the revised criteria for municipal solid waste landfills (MSWLFs) (6). This proposed action would amend Part 257 by including information requirements for owners and operators of industrial solid waste disposal facilities including surface impoundments, landfills, land application units, and

waste piles, and construction/demolition waste landfills and by excluding MSWLFs from Part 257 criteria. The new Part 258 proposes requirements for MSWLFs, including those that codispose of sewage sludge with household waste.

The new Part 258 identifies revised minimum criteria for MSWLFs in the form of performance standards, including siting, facility design and operation, groundwater monitoring, corrective action requirements, closure-post closure care, and financial responsibility. The goal of the new requirements is to provide flexibility to the States and minimize disruption of current practices while protecting the human health and the environment. Part 258 will be enacted under the authorities of the Clean Water Act and RCRA. Regulations covering monofills will be promulgated in the future under the Clean Water Act.

The proposed Part 258 addresses location standards, design requirements, operating standards, financial responsibility, ground water monitoring and closure and post-closure care has five subparts. Subpart B concerns location restrictions--proximity to airports, floodplains, wetlands, fault areas, seismic zones, and unstable areas. Subpart C is the Operating Criteria--day-to-day operations, closure and post closure criteria, and financial assurance. Subpart D, Design Criteria, would establish a performance standard that allows States flexibility in determining the allowable risk level and the point of compliance. New facilities will be required to be designed with liners, leachate collection systems, and final cover systems, as necessary, to meet a State-established design goal. The design goal would be risk based and would be in the range of lifetime cancer risk of 1×10^{-4} to 1×10^{-7}. Existing facilities will not be required to retrofit liners and leachate collection systems but will be required to install final cover

systems. Subpart E describes the Groundwater Monitoring and Corrective Action requirements. The groundwater monitoring will be accomplished in two phases. In Phase I, indicator parameters will be monitored. Phase II would be implemented when contamination occurs and increased monitoring and characterization will be required. A corrective action assessment would be required if Phase II constituents are exceeded. The States would be required to evaluate the corrective action measures, select the remedy, establish standards, and set the schedule for completing corrective action.

Use of Geosynthetics

Clearly both Subtitle "C" and Subtitle "D" require control measures. The "C" requirements are very straightforward in defining the use of geosynthetics for control barriers, drainage media, and infiltration barriers. Currently these materials are being employed in landfill designs, and their increased use is easily predictable as the engineering community becomes more familiar with how to design with geosynthetics. The Subtitle "D" requirements do not emphasize the use of geosynthetics, because States play a major role in establishing the design criteria. A few States have anticipated their role and include their use in waste management criteria that are nearing completion. Preliminary indications are that geosynthetics will continue to be used as barriers and drainage material. The regulated community and the States need to work together to develop test procedures applicable to field designs and to support research that would identify material limitations. The short- as well as the long-term durability of these products must be clearly understood by both designers and regulators. Improved quality control/quality assurance procedures will ensure the best designs and implementation.

Summary

As the waste management industry gains field experience and as a better understanding of material design becomes available, waste disposal facilities will continue to improve. Future regulations which will provide guidance on materials and design, will demonstrate to the public that the intent of professional business is to manage the Nation's waste in a manner protective human health and the environment.

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